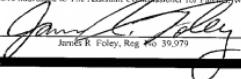


PATENT

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WEB BASED OLA MEMORY GENERATOR

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Field of the Invention

The present invention generally relates to software, OLA (Open Library Architecture) libraries, and growable memories, and more specifically relates to a system and architecture for building OLA memory modules, such as a web based OLA memory generator.

Background of the Invention

Currently, to calculate delay associated with an integrated circuit, a delay calculation tool is used. The delay calculation tool reads in a netlist and obtains the characterized timing and power information from a compiled file, and then creates a Standard Delay Format (SDF) file based on the loading and interconnect information for the netlist.

The compiled file basically stores all characterization data for a single standard cell, and is basically a compiled version of another file (a “tech file”) which is the ASCII human readable format that has the timing/power information. For memories, the delay calculation tool creates a file (i.e. an annotate.v file) that has most of the timing information, and this file is created again based on the characterization information in the tech file specific to a memory type.

When performing Static Timing Analysis (STA) on the netlist using, for example, Synopsys PrimeTime, one would need the SDF file created by the delay calculation tool and also the timing information in Synopsys proprietary format (.lib files). In other words, both SDF files and .lib files (such as Synopsys proprietary files) are required.

Currently, there is no single source (repository) for timing/power information accessible to a multitude of 3rd party tools without the hassle of having to support multiple or vendor specific formats to store/represent this information. There is no architecture currently available to streamline and accurately represent all information that is specific to a given set of technologies. There is no standardized view that accurately represents timing, power and functional information for a third party tool.

Objects and Summary of the Invention

A general object of an embodiment of the present invention is to provide a system while eliminates the need to use Standard Delay Format (SDF) files for timing verification.

Another object of an embodiment of the present invention is to provide a standardized view that accurately represents timing, power and functional information for a third party tool.

Still another object of an embodiment of the present invention is to provide a system and architecture which allows the ability to represent technology specific information for timing and power with regards to memories supported by a given set of technologies.

Still yet another object of an embodiment of the present invention is to provide a system and architecture for providing a user with a Delay and Power Module for memories.

Yet still another object of an embodiment of the present invention is to provide an infrastructure which allows a user to dynamically create configurations of memories that are needed.

Yet still another object of an embodiment of the present invention is to provide a server which eliminates the need to provide compilers at each of the users' stations.

Briefly, and in accordance with at least one of the foregoing objects, an embodiment of the present invention provides a system for generating an Open Library Architecture Delay and Power Calculation Module. The system includes a user interface for generating and submitting a request to a server. The request specifies a configuration and type of memory for which an Open Library Architecture Delay and Power Calculation Module is needed. A server is configured to receive the request from the user interface, and produce the Open Library Architecture Delay and Power Calculation Module in response to the request.

Preferably, the user interface includes a memory generation tool that is used to create a Delay Calculation Language model, and the user interface is configured to generate the request based on the Delay Calculation Language model. Preferably, the memory generation tool uses a library of templates to create the Delay Calculation Language model. The user interface is preferably configured to create a Hyper Text Markup Language file based on the Delay Calculation Language model. Ideally, the Hyper Text Markup Language file is configured to allow the user to select a memory configuration and type for which an Open Library Architecture Delay and Power Calculation Module is needed.

Preferably, the server is configured to receive the request for the Open Library Architecture Delay and Power Calculation Module from the user interface and is configured to generate the Open Library Architecture Delay and Power Calculation Module in response to the request. Specifically, the server creates a Delay Calculation Language memory module based on the request, and compiles the Delay Calculation

Language memory module into C-source, and compiles the C-source into the Open Library Architecture Delay and Power Calculation Module.

The server may include, for example, Common Gateway Interface/Practical Extraction and Report Language Script which is configured to process the request, or may include, for example, a C program or other code for processing the request. If Common Gateway Interface/Practical Extraction and Report Language Script is provided, the script may be configured to process the request by sourcing necessary environment variables, running the memory generation tool to create the Delay Calculation Language memory module, invoking a first compiler to compile the Delay Calculation Language memory modules into C-source, and invoking a second compiler to compile the C-source to create the Open Library Architecture Delay and Power Calculation Module. Preferably, the script is configured to create Delay Calculation Language side files which are used during the compilation with information on relevant include files and calculation files. Ideally, once the server has generated the Open Library Architecture Delay and Power Calculation Module, the Open Library Architecture Delay and Power Calculation Module can be downloaded from the server.

Brief Description of the Drawings

The organization and manner of the structure and operation of the invention, together with further objects and advantages thereof, may best be understood by reference to the following description, taken in connection with the accompanying drawings, wherein like reference numerals identify like elements in which:

FIGURE 1 is a block diagram of a system which is in accordance with an embodiment of the present invention, wherein the system includes a user interface configured to generate a request and forward the request to a server which generates an Open Library Architecture Delay and Power Calculation Module in response to the request; and

FIGURE 2 is a flow diagram of the system shown in FIGURE 1.

Description

While the invention may be susceptible to embodiment in different forms, there is shown in the drawings, and herein will be described in detail, a specific embodiment with the understanding that the present disclosure is to be considered an exemplification of the principles of the invention, and is not intended to limit the invention to that as illustrated and described herein.

FIGURE 1 illustrates a system 10 which is in accordance with an embodiment of the present invention. The system 10 includes a user interface 12 which is configured to generate a request and forward the request to a server 14. The server 14 is configured to generate an Open Library Architecture Delay and Power Calculation Module (OLA DPCM) in response to the request received from the user interface 12. The system does not require the use of SDF and .lib files, and effectively provides a single source (repository) for timing/power information which is accessible to a multitude of 3rd party tools without the hassle of having to support multiple or vendor specific formats to store/represent this information. The system also streamlines and accurately represents all information that is specific to a given set of technologies and provides a standardized view that accurately represents timing, power and functional information for a third party tool. The system allows a user to dynamically create configurations of memories that are needed, without having to provide compilers at each station.

FIGURE 2 is a flow diagram of the system shown in FIGURE 1, and provides a more detailed illustration. As shown, the “user end” or user interface 12 includes a library of memory templates 18, memory files 20 (“.cli” in FIGURE 2), a library of memories 22 (“Memory Panlibs” in FIGURE 2), and a memory generation tool 24 (“LSIMMEMORY” in FIGURE 2) which is configured to read and create DCL models. Preferably, the user interface 12 also includes a switch 26 (“gen_ola_html”) which effectively tells the memory generation tool 24 to create an HTML file 28 that the user can load into a browser. The HTML file 28 allows the user to select the configuration/types of memories for which he or she needs an OLA DPCM.

As shown in FIGURE 2, the “user end” or user interface 12 is interfaced with the “server end” or server 14 across an interface boundary 30. The user interface 12 is configured such that a user can use the interface 12 to generate a request for an OLA DPCM and submit the request to the server 14 across the interface boundary 30. The server 14 is configured to process the request and provide the OLA DPCM.

The server 14 includes a library of DCL templates 32, a library of memories 34 (“Memory Panlibs” in FIGURE 2), a DCL model generation tool 36 (“LSIMEMORY” in FIGURE 2) for generating a DCL model 37 (“<mem>.dcl”) based on the request which is received from the user interface 12, a first compiler 38 for compiling the DCL model 37 into C-source 40, and a second compiler 42 for compiling the C-source 40 to create an OLA DPCM 44. The OLA DPCM 44 is preferably provided in the

form of an output which is downloadable across the interface boundary 30 at the “user end” (i.e. via the user interface 12).

The server includes code 50, such as CGI/PERL script and other associated script, for processing the request received from the user interface 12. If the code is provided as CGI/PERL script, the script may be as follows:

```
#!/usr/local/bin/perl

##$PREFIX="/lsi/home/pd/WWW/cgi-bin/CDCT_BALAJI/OLA";
$PREFIX="/lsi/dv/cdct_www/ola/ola_mem_run_dir";
$session_id="ola_$$";
$LOGPREF="$PREFIX/$session_id/run_";
STABLE_DEF_PATH = "/lsi/home/ola/dev/generic_data/include";
$ndcl = "/lsi/home/ola/bin/SOL/bin/ndcl";

select((select(STDOUT, $|= 1) [0]);
select((select(STDERR, $|= 1) [0]);
print "Content-type: text/html\n\n";
&Parse_form;

sub ErrorMessage
{
    print "The server cannot open the file. It does not exist or the permissions are
wrong.\n";
    exit(0);
}

sub Parse_form
{
    if ($ENV{'REQUEST_METHOD'} eq 'GET') {
        @pairs = split(/&/, $ENV{'QUERY_STRING'});
    }
    elsif ($ENV{'REQUEST_METHOD'} eq 'POST') {
        read (STDIN, $buffer, $ENV{'CONTENT_LENGTH'});
        @pairs = split(/&/, $buffer);
    }
}
```

```

}
else {
    print "Content-type: text/html\n\n";
    print "<P>Use Post or Get";
}

foreach $pair (@pairs) {
    ($key, $value) = split (/=/, $pair);
    $key =~ tr/+/ /;
    $key =~ s%([a-fA-F0-9][a-fA-F0-9])/pack("C", hex($1))/eg;
    $value =~ tr/+/ /;
    $value =~ s%([a-fA-F0-9][a-fA-F0-9])/pack("C", hex($1))/eg;

    $value =~s/<!--(.|\n)*-->/g;

    if ($formdata{$key}) {
        $formdata{$key} .= ", $value";
    } else {
        $formdata{$key} = $value;
    }
}

foreach $key (sort keys(%formdata)) {
    if ($formdata{$key} eq "") {
        print "<P>The field $key was not filled in. A value must be entered to process
your request.";
        exit(0);
    }
    if ($key eq OLALibNameEntryBox) {
        $dpclibname = $formdata{$key};
    }
}
}

#HTML section
print "<HTML><HEAD>\n<TITLE>";
print "</TITLE>\n</HEAD><BODY bgcolor=\"#fffff\">\n";
print "</BODY></HTML>";
mkdir "$PREFIX/$session_id", 0777;
`chmod -R 777 $PREFIX/$session_id`;
chdir "$PREFIX/$session_id";
$logname = $LOGPREF.$session_id.".log";

```

```

print "<br><br>";
print "<center><b><u><font size=\\\"5\\\" face=\\\"Arial\\\">Executing OLA memory
generation Step 1 of 2 ----Running lsimemory----</font></b><br><
/center></u>";

#Running lsimemory to create the DCL models

foreach $memory (keys %formdata) {
    next unless ($memory =~ /memchk/i);
    print "<P>Running $formdata{$memory}\n";
    `touch lsitk.options`;

    #Create Write permissions for lsitk.options.
    `chmod 777 ./lsitk.options`;

    @run = `rsh -l pd dv53s46 /lsi/dv/cdct_www/ola/scripts/scr
\\\"$formdata{$memory}\\\" $Slogname $PREFIX/$session_id`;

    #  print @run;
}

print "<br>";
print "<br>";
print "<br>";
print "<center><b><u><font size=\\\"5\\\" face=\\\"Arial\\\">Executing Step 2 of 2 ----DCL
Compilation----</font></b><br></center></u>";
print "<P>\n";
print "SLSI_RELEASE";

#Copy any existing DCL models from ./memory/OLA dir to CWD.
$Soladir = "memory/OLA";
#if ($Soladir) {
#  `cp memory/OLA/*.dcl`;
#}

#Iterate thru the DCL to get technology specific information and create
<tech>_memory.dcl etc.
foreach $file (*.dcl)
{
    open (DCL, $file);
    while (<DCL>)
    {
        if (/Technology\s*:\s*(lcbg12|gflux)/) { push @{$techs{$1}}, $file; last; }
    }
}

```

```

}

}

foreach $tech (keys %techs)
{
    open (FILE, ">${tech}_memory.dcl");
    print FILE "// Set the technology\n";
    print FILE "tech_family(${tech});\n";
    print FILE "\n";
    print FILE "// Table definitions\n";
##### NEW INCLUDE FILES #####
    print FILE "#include \"$STABLE_DEF_PATH/memory/table_import.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/memory/import.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/memory/method.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/memory/common.inc\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/memory/table_empty.data\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/all/table_import.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/all/import.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/all/method.dcl\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/all/common.inc\"\n";
    print FILE "#include \"$STABLE_DEF_PATH/all/table_empty.data\"\n";
#####
    # print FILE "#include \"$STABLE_DEF_PATH/lib_table_import.dcl\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/memory_table_import.dcl\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/import.dcl\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/memory_import.dcl\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/common.inc\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/lib_table_empty.data\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/memory_table_empty.data\"\n";
    # print FILE "#include \"$STABLE_DEF_PATH/method.dcl\"\n";
    print FILE "\n";
    print FILE "// Library Specific Properties\n";
    print FILE "#include \"${tech}_Cell_List.data\"\n";
    print FILE "\n";
    print FILE "// Cell Specific Properties\n";

foreach $file (@{$techs{$tech}})
{
    print FILE "#include \"$file\"\n";
}

print FILE "calc(LATENT_EXPRESSION):\n";

```

```

print FILE " result (\n";
print FILE "   integer: n = messageLoadRule('${tech}_memory'),\n";
print FILE "   n = addLibrary('${tech}_memory','${tech}_memory')\n";
print FILE " );\n";

open (FILE, ">${tech}_Cell_List.data");
print FILE "table (Cell_List) :\n";
#print FILE "table ( ${tech}_Cell_List) :\n";
print FILE " ${tech}_memory :\n";

@starlist = ();
@behavlist = ();
@tmplist = @{$techs{$tech}};
foreach $file (@tmplist)
{
    $file =~ s/^dcl//;
    push @starlist, "*", "*";
#    push @behavlist, "behavior", "timing";
    push @behavlist, "power", "timing";
}
@tmplist = sort (@tmplist, @tmplist);
$list = join "\\", \@tmplist;
$starlist = join "\\", \@starlist;
$behavlist = join "\\", \@behavlist;

$list = uc($list);

print FILE " [ '$list' ]\n";
print FILE " [ '$starlist' ]\n";
print FILE " [ '$behavlist' ] ;\n";
print FILE "end;\n";

close FILE;

# Set the license file for ndcl and c compiler. Set path to c compiler and linker.
$ENV{"LM_LICENSE_FILE"} =
"/lsi/dv/licenses/si2:/lsi/soft/sc-5.0/license_dir/license.dat";
$ENV{"PATH"} = "/lsi/soft/sc-5.0/bin:/usr/ccs/bin:/usr/local/bin";

# Call ndcl to compile the concatenated dcl files
@ndcl = `ndcl -DCOMPILER_MODELS -v -o $tech_${dpcmlibname}
${tech}_memory.dcl 2>&1`;
##print @ndcl;

```

```

@ndcl = `Sndcl -DCOMPILER_TABLES -v -dt ${tech}_memory.dcl 2>&1`;
###print @ndcl;
}

#Check for existence of the dpcm
if (-f "Stech_${dpcmlibname}") {
  `/usr/local/bin/mkdir Stech_${dpcmlibname}.dir` ;
  `chmod -R 777 Stech_${dpcmlibname}.dir` ;
  `/usr/local/bin/mkdir Stech_${dpcmlibname}.dir/data` ;
  `chmod -R 777 Stech_${dpcmlibname}.dir/data` ;
  `/bin/mv Stech_${dpcmlibname} Stech_${dpcmlibname}.dir` ;
  `/bin/mv *.table Stech_${dpcmlibname}.dir/data` ;
  `/usr/bin/tar cvf Stech_${dpcmlibname}.tar Stech_${dpcmlibname}.dir` ;
  `/usr/local/bin/gzip Stech_${dpcmlibname}.tar` ;

#### `/bin/ln -s SPREFIX/$session_id /lsi/dv/cdct_www/ola/temp`;
  print "<br><h3 align="center"><A
HREF=\\\"http://gresham5.lsil.com/gread/cdct_www/ola/ola_mem_run_dir/$session_id/
Stech_${dpcmlibname}.tar.gz\\">Download Result By Shift-Clicking Here</a></h3>\n" ;

print "<br><b><center><font color=\\"#ff0000\\" size=\\"3\\" face=\\"Arial\\">----Clean
up of results is done every Tuesday at 2:00 AM PST----</
font></b><br></center>";

#Create Write permissions for the log and memory sub-directories.
`chmod "SPREFIX/$session_id"`;
`chmod -R 777 *`;

}

#Delete the session id directory
`chdir "$PREFIX/"`;
`/bin/rm -rf SPREFIX/$session_id`;

```

The foregoing script may be configured to invoke other script such as:

```
#!/bin/csh -f

setenv LSI_PERL      ~usr/local/bin/perl5.00503
setenv LSIADMIN      ~lsirels
setenv LSI_LICENSE_FILE ~lsirels/generic/acctmgr/license.dat
setenv LSI_RELEASE    $LSIADMIN/lsi_fs_3.0
setenv TK_NOHIERARCHY TK_NOHIERARCHY_ON

source $LSI_RELEASE/scripts/lsi.alias
source $LSI_RELEASE/scripts/lsi.setenv

### $1 contains the command, $2 contains the log file, $3 contains the run dir.
cd "$3"
###cp /lsi/home/ccrisan/FS30/src/lsimemory/obj/SunOS-5.7/lsimemory .
$1 >> $2

/bin/chmod 777 run_ola*
/bin/chmod -R 777 *.log
/bin/chmod -R 777 rr*
/bin/chmod -R 777 RR*
/bin/chmod -R 777 *.cli
/bin/chmod -R 777 *.pan
```

Use of the system 10 will now be described. Initially, the user knows what specific memory configurations he needs and what type of memories, specified in a .cli file 20, and the user has access to “LSIMEMORY”, the memory generation tool 24. The user interface 12 is configured such that the environment is set up correctly for the user to access memory templates 18 and other technology specific files. The memory generation tool 24 reads the DCL templates to create DCL models (an intermediate output format). When the “gen_ola_html” switch 26 is used with the memory generation tool 24, the memory generation tool 24 creates an HTML file 28

that the user can load into a browser. The user loads the HTML file 28 and selects the configurations/types of memories for which he or she needs an OLA DPCM and then submits a request to the server 14. The CGI/PERL script (or other code) 50 then processes the request by: sourcing the necessary environment variables, running the DCL model generator 36 to create DCL models 37, invoking the DCL compiler 38 to compile the DCL models 37 into C-source 40, creating DCL side files which are used during DCL compilation with information on relevant include files and calculation files (60 in FIGURE 2), invoking the C-compiler 42 to compile the C-source 40 which has been created in order to create the OLA DPCM module 44, and creating a link to the newly created OLA DPCM module 44 which the user can use to download the OLA DPCM module 44 which has been generated by the server 14.

The system provides a web based system of creating OLA memories, provides that memories of any type/configuration can be generated on the fly, eliminates the need for DCL/C compilers in the field (i.e. at each user interface), and provides an ideal, easy to access and easy to use OLA solution. Additionally, being web based, the system is very accessible. By eliminating the need for DCL/C compilers in the field (i.e. at each user interface), the system is cost effective. Furthermore, there is a reduction in cycle time owing to the dynamic nature of the memory generation scheme.

While an embodiment of the present invention is shown and described, it is envisioned that those skilled in the art may devise various modifications of the present invention without departing from the spirit and scope of the appended claims.